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THE ACADIAN TRIASSIC

SIDNEY POWERS
Troy, New York

PART II

Gerrish Mountain.—Gerrish Mountain consists of a basalt flow capping Triassic sandstones (Figs. 20, 22). The sandstones on the west side of the mountain are horizontal, those on the east side dip northward at angles of 15° or less.

Opposite Moose Island is a cross-section of the basalt flow (Fig. 22), showing sandstone faulted against agglomerate on the west, with the agglomerate overlain by sandstone in one exposure; a columnar basalt dike east of the agglomerate, and probably separated from it by a fault; and red sandstone, east of the dike, overlain by a 3-foot bed of ash, above which is columnar basalt. The dike is 50 feet thick. It extends northward for some distance, but it is cut off on the south by a fault between the mainland and Moose Island. In either the dike, or the basalt flow, magnetite has been mined near Lower Economy.

The final exposure of Triassic basalt on the east, which may originally have been connected with that at Gerrish Mountain, is at Portapique Mountain, 12 miles distant, and north of Birch Hill (see Fig. 23).

Gerrish Mountain–Truro.—The broad lowland underlain by Triassic strata east of Gerrish Mountain is interrupted by a long strip of Carboniferous conglomerates and shales forming a high, rugged topography from Lower to Upper Economy, as shown in Figs. 19 and 24, rising 250 feet, or more, from the lowland on the south. The relation of the Triassic to the older rocks, as seen along the shore, is a fault west of Carr Brook, and an unconformity near Lower Economy (Fig. 25).

At the fault, the Triassic consists of very calcareous sandstones, containing conglomerate lenses and cross-bedding. Calcite has been introduced into the sandstone, forming dark-red concretions.

The unconformity near Lower Economy shows a basal conglomerate composed of subangular pebbles 1 to 3 inches in length, resting on upturned and leveled Carboniferous red shale. The shale within a foot of the contact is weathered into a clay, but this weathering is of recent date. The basal Triassic conglomerate pebbles consist of slate, schist, quartz, and igneous rocks from the Cobequid Mountains. Above the basal conglomerate, which is 25 feet thick, are interbedded sandstones and conglomerates as seen in Fig. 26. It is 1,200 feet stratigraphically between the basal unconformity and the Gerrish Mountain basalt flow.

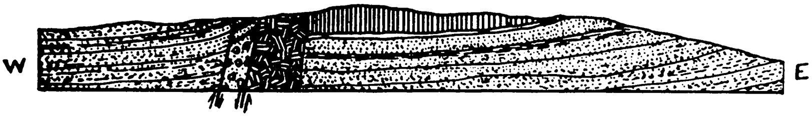

FIG. 22.—The shore section along Gerrish Mountain, as seen from the eastern end of Moose Island. The Triassic sandstone, at the left, is faulted against a mass of agglomerate overlain by a capping of sandstone. The agglomerate is probably faulted against the dike of diabase, which has fed the basalt flow which caps the cliffs on the right. At the base of this flow is a bed of green ash, and beneath this is normal Triassic sandstone, with some shale.

From Economy to Truro, Minas Basin is fronted by a comparatively low land underlain by practically horizontal Triassic sandstones, above which, in places, are Pleistocene gravels.

The northern contact is of importance because there is a question whether there is a fault or an unconformity. The exposures are confined to the steam valleys, and are quite unsatisfactory. It may be briefly stated that the relation is probably a fault as far as Chiganois River, with another fault from there to North River,

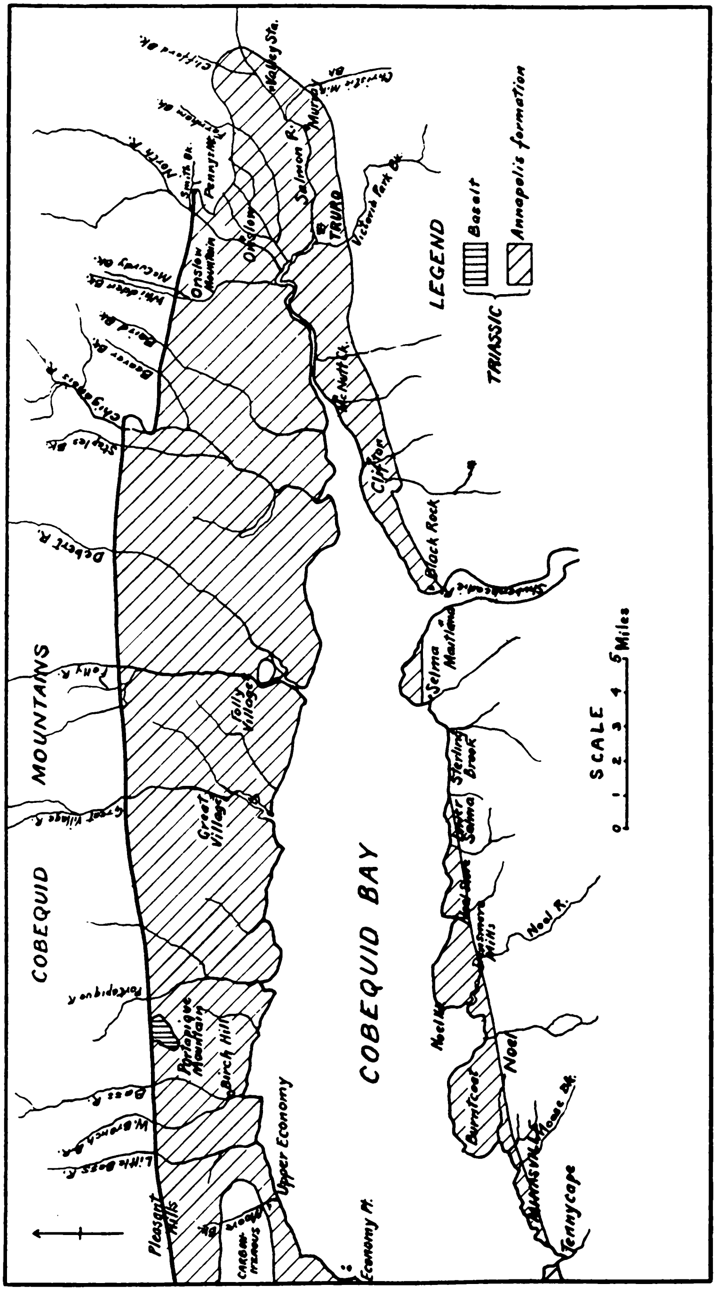

FIG. 23.—Map of the head of Minas Basin

as shown in Fig. 23. The evidences which favor this conclusion are the apparently dragged dips of the Triassic in several cases; and the lack of pebbles of adjoining older rocks in the Triassic conglomerates near by, and the actual fault seen in Harrington River on the west.[1]

At Birch Hill and at Folly Village, older rocks project through the Triassic strata according to Fletcher, who mapped both localities with exaggeration of their size. There are reasons for questioning the existence of older rock at Birch Hill, but the copper prospect where these rocks are supposed to occur was not visited in the reconnoissance.

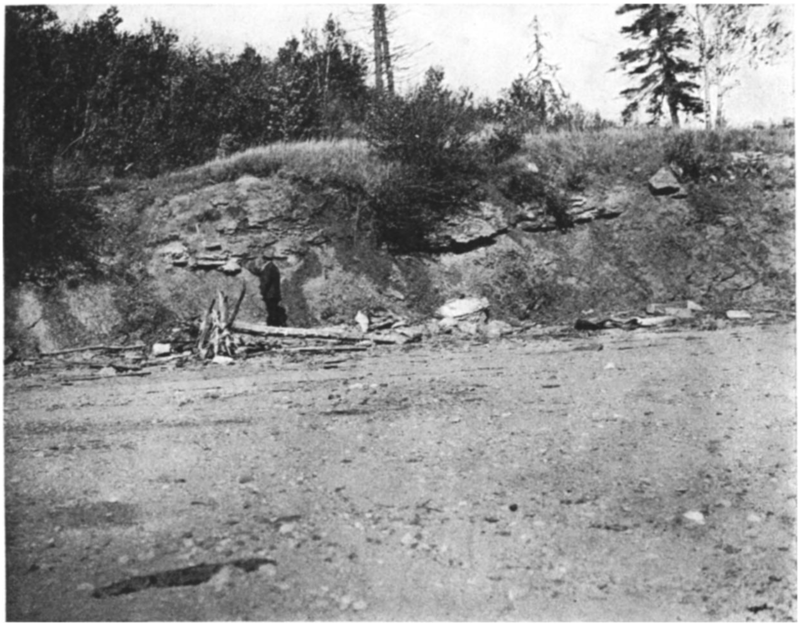

FIG. 24.—The base of the Triassic at Minasville, showing the basal sandstones and conglomerates resting on horizontally trunkated Carboniferous shales. The character of the erosion surface indicates a peneplain, and the composition of the basal conglomerate indicates a lack of residual soil on this surface at the beginning of Triassic sedimentation.

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[1] Certain of the localities are described by H. Fletcher, *Geol. Surv. Canada*, *Ann. Rept.*, V (1892), 142–43 P.

At Folly Village, Mississippian fossiliferous limestone and gypsum, belonging to the Windsor group, appear on the northwest side of Debert River. The Triassic sandstones are very calcareous, and resemble the Windsor limestones, as both are red in color. It appears that the limestone is overlain conformably by the gypsum, and that these Mississippian strata are overlain disconformably by the Triassic red sandstones. With this view, the Mississippian is confined to a small area on the northwestern side of Debert River where fossils are readily found.[1]

Truro–Wolfville.—The end of the arm of Triassic in Minas Basin lies near Truro, and the relation of these to the older rocks is an unconformity, as shown in Fig. 23. This unconformity is well exposed in Salmon River and in Victoria Park Brook (where there is also a fault). The underlying Carboniferous strata always show a beveled surface. This unconformity continues along the south shore of Minas Basin, and may be seen at Minasville, on the sides of Moose Brook (Fig. 24), at Tennycape, and at Walton. Over this area the Triassic sandstones show nothing unusual, except for calcitization north of Maitland.

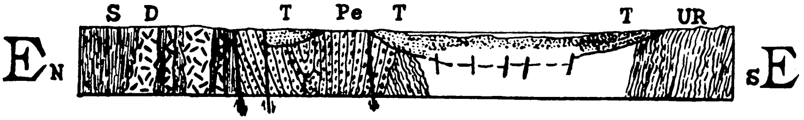

FIG. 25.—Section EE. Structure section through Minas Basin near Bass River, to show the unconformity of the Triassic on an island of Permian strata, Parrsboro formation, just north of the Basin. *SD*, Cobequid group; *UR*, Union-Riversdale series (Pennsylvanian); *Pe*, Permian. The major Cobequid fault is shown at the south of the Cobequid group. The closely folded syncline of the Parrsboro formation is in part overlain by Triassic sediments (*T*), which appear to be down-faulted on the north.

West of Cheverie, the first exposure of Newark rocks is at Oak Island, north of Avonport (Fig. 3). On the east side of this island, quartz-pebble conglomerate and sandstone are exposed, overlain by stratified Pleistocene gravels, 6 feet thick, above which is Wisconsin till.

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[1] This view differs from that of J. W. Dawson, *Acadian Geology*, 3d ed., 1878, p. 99.

North of Oak Island is Boot Island, which is separated from the mainland, called Long Island, by a narrow channel, formed within the last two centuries. North of this channel is a buried forest, exposed at low tide. North of Boot Island, and on the north side of Long Island, are exposures of red sandstones with occasional thin shales in which Dr. H. M. Ami reports the presence of *Estheria ovata*.[1]

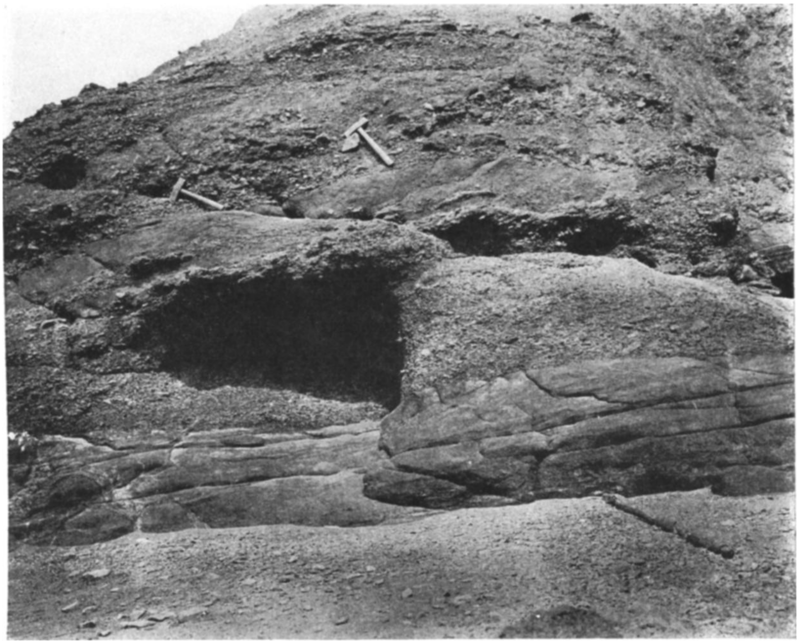

FIG. 26.—Details of the Triassic sandstone and conglomerate 30 feet above the base of the Annapolis formation, one mile east of Lower Economy.

At Wolfville the basal Triassic unconformity is exposed in a small brook west of the buildings of Acadia College, resting horizontally on upturned and beveled slates of the Meguma series.[2] The basal unconformity is again exposed at Kentville, just below the mill on Black River.[3]

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[1] Verbal communication.

[2] The writer is indebted to Professor Ernest Haycock of Wolfville for pointing out this locality.

[3] J. W. Dawson, *op. cit.*, p. 92; L. W. Bailey, "Geology of Southwestern Nova Scotia," *Geol. Surv. Canada, Ann. Rept.*, IX (1898), 128 M.

Wolfville-Scots Bay.—The Wolfville sandstone outcrops on the exposed points between Wolfville and Pereau River, the most continuous exposure being near Kingsport. The sandstone contains occasional conglomerate beds and red shales. The proportion of shale to sandstone gradually increases toward Blomidon. The shale in this locality is largely a red clay, with occasional green bands, persisting horizontally throughout the exposure. The general dip of the strata is 5°–10° northward. Small faults are numerous.

About midway between Kingsport and Pereau River, Haycock found fragments of well-consolidated fossiliferous red shale in till, overlying the Triassic.[1] The fossils are *Estheria ovata.* Dipping under North Mountain are poorly consolidated Blomidon shales, with the characteristic thin green beds at distances of 10–20 feet.

The Blomidon shale continues around the hook of North Mountain beyond Cape Blomidon, but not as far as Amethyst Cove. At the latter locality, basalt cliffs, partly columnar, rise abruptly from the sea to a height of 300 to 400 feet. These cliffs are kept vertical by frost action on the vertical joint planes parallel to the shore.

Two basalt flows are visible at Amethyst Cove, dipping gently northward, with undulating folds. The collecting place for amethysts is in a greatly veined area about 100 feet below the top of the lower flow.

Scots Bay-Bennetts Bay.—In the region around Scots Bay there are two points of especial interest: first, the origin of the curve in North Mountain at this point, and, secondly, the presence of the Scots Bay formation overlying the North Mountain basalt along the southeast side of the Bay. Furthermore, the structural evidence furnishes a clue to the former thickness of the younger formation.

The curve in North Mountain is formed in a syncline pitching down to the west, and in the nose of this syncline Scots Bay has been eroded (see Figs. 27, 28). The basalt flows of North Mountain dip toward the Bay on all sides at angles of 3°–5°. The topographic slope follows the dip slope closely, beveling it slightly. At the water's edge there is no sea-cliff, but merely a sheet of basalt (where exposed) sloping upward from the shore. Farther southwest along North Mountain there are low sea-cliffs, but the general dip-slope persists to the end of Brier Island. The crest of North Mountain is a mile or two southeast of the Bay of Fundy shore. It is a uniformly rolling surface which bevels the tilted basalt flows and forms a remnant of the Summit peneplain.

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[1] E. Haycock, "Fossils in the Boulder-Clay of Kings County, Nova Scotia," *Trans. N.S. Inst. Sci.*, X (1901), 376–78.

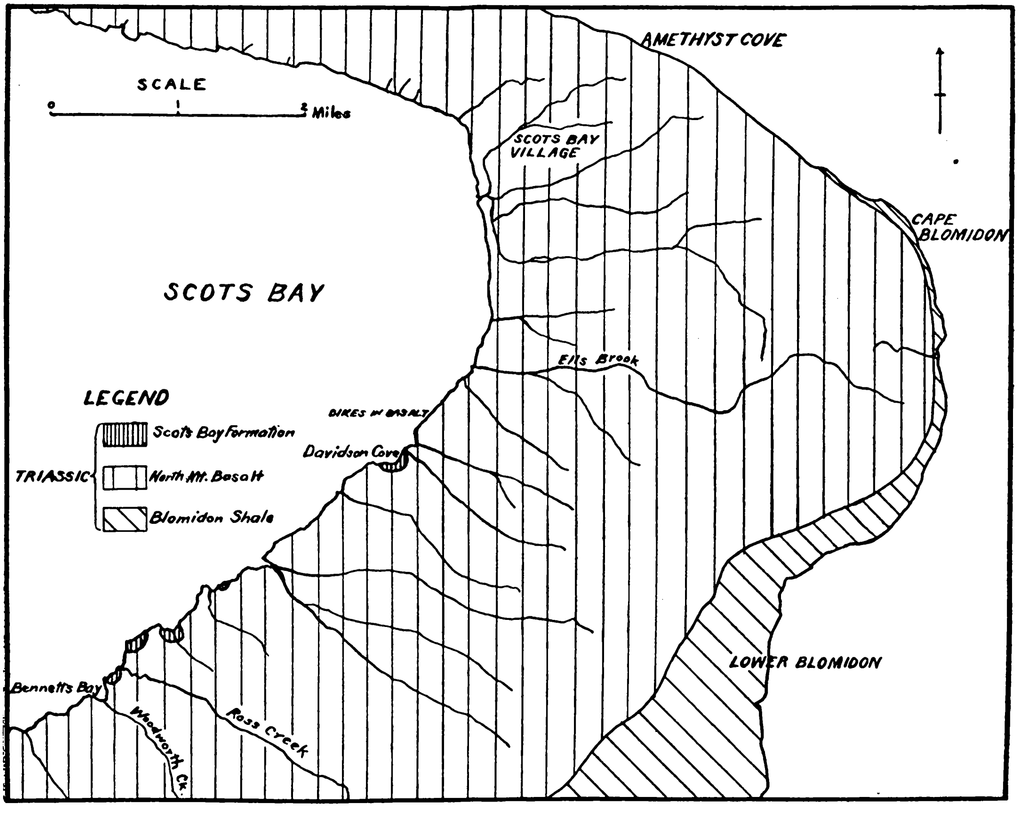

FIG. 27.—Map of the Scots Bay–Cape Blomidon region

Around Scots Bay the top of the uppermost basalt flow is marked by a green amygdaloidal layer in which the amygdules are one-half to three-quarters of an inch long. This amygdaloid outcrops on the shore from Bennetts Cove to Ells Brook (Fig. 27). From this point to the north shore of the Bay there are no outcrops. Along the north shore toward Cape Sharp, the amygdaloid has been eroded, exposing the solid basalt beneath. In places this basalt is columnar, and in other places it contains balls, a foot or more in length, composed of dense basalt surrounded by amygdaloidal rims. The balls are not sufficiently abundant for the basalt to be called a pillow lava.

The younger, sedimentary formation, named for its occurrence on the south side of Scots Bay, the Scots Bay formation, has a thickness of 25 feet. It was discovered by Ells in 1876, and described by him[1] and later by Haycock.[2] It consists of white, very calcareous sandstone, quite distinct in color from any other Triassic sandstone of Acadia, with some interbedded shale and normal sandstone.

The Scots Bay formation outcrops in five small synclines between Scots Bay and Bennetts Bay (formerly called Woodworth Bay). These small remnants rest conformably on the basalt, contrary to the opinion of Haycock, and are preserved in small synclines in the basalt. They extend southeast only a few hundred feet, as the topographic slope of the

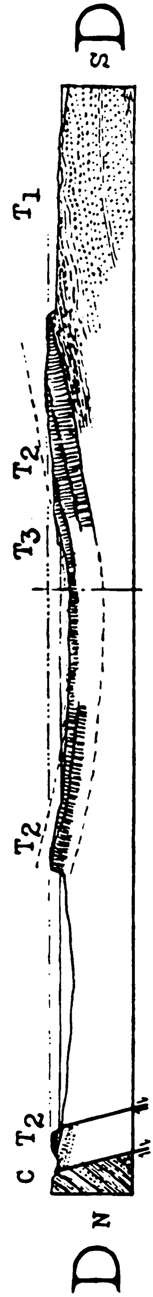

FIG. 28.—Section DD. Geologic cross-section through Cape Sharp on the north; Cape Split, Scots Bay, and Cape Blomidon, on the south. *C*, Carboniferous; T_1, Triassic, Annapolis formation; T_2, North Mountain basalt; T_3, Scots Bay formation. The vertical scale from Cape Split southward is exaggerated to show the overlying Scots Bay formation which is only 25 feet thick. The level of the Summit peneplain is shown by the line with three dots and a dash, the top of the flows of North Mountain by the finely dashed line. The area between these two lines must have been filled with the Scots Bay formation at the time the Summit peneplain was developed.

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[1] R. W. Ells, "Notes on Recent Sedimentary Formation on the Bay of Fundy Coast," *Trans. N.S. Inst. Sci.*, VIII (1894), 416–19.

[2] Ernest Haycock, "Records of Post-Triassic Changes in Kings County, Nova Scotia," *ibid.*, X (1900), 287–302.

mountain cuts across them and the flows at a low angle. These synclines are shown in Fig. 27.

The Scots Bay formation consists of calcareous white or gray sandstone, frequently replaced by chert, and greenish sandstone or shale. The exposures are nowhere over 15 feet in thickness (Fig. 29) and are remnants of a formation which once filled the syncline of Scots Bay up to the level of the Summit peneplain, as shown in Fig. 28. The white sandstone, or chert, rests directly on the amygdaloid at the top of the basalt flows, and veins of chert run downward from the sandstone into the amygdaloid. The beds in any one syncline do not match exactly with those in any other, but this condition is to be expected in basal beds of which only a few feet are shown, on the irregular top of a lava flow.

Fossils have been found in the calcareous sandstones by Haycock. They consist of faint green markings, probably plant remains; worm burrows; fish scales, bones, coprolites, and other

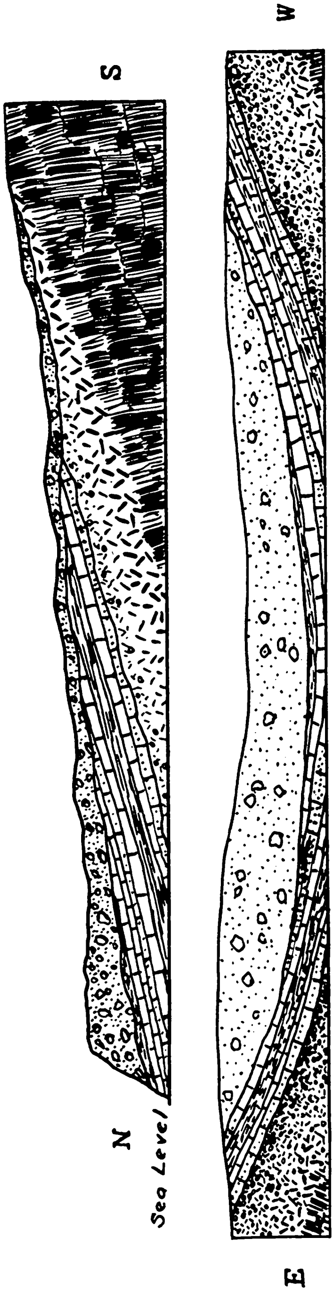

FIG. 29.—Structure sections of a syncline of the Scots Bay formation, lying conformably over the top of the North Mountain basalt. Above the Scots Bay formation is till, filling the pre-Wisconsin valley. The top of the upper flow is very amygdaloidal. The basal beds of sandstone have been replaced by chert.

fragments of fish. The coprolites are from 1 to 1½ inches in length, an inch wide, and half an inch thick. In 1913, Haycock found a portion of the head of a fish which has been identified by Mr. L.M. Lambe as the Triassic genus, *Semionotus fultus* (Agassiz).

Digby Gut.—Between Kentville and Digby Gut there are few outcrops of the Annapolis formation and no cross-sections of the North Mountain basalt. The best cross-section of the latter is at Victoria Beach, on the east side of Digby Gut (Fig. 30). The exposures on the west side of the Gut are disturbed by faulting.

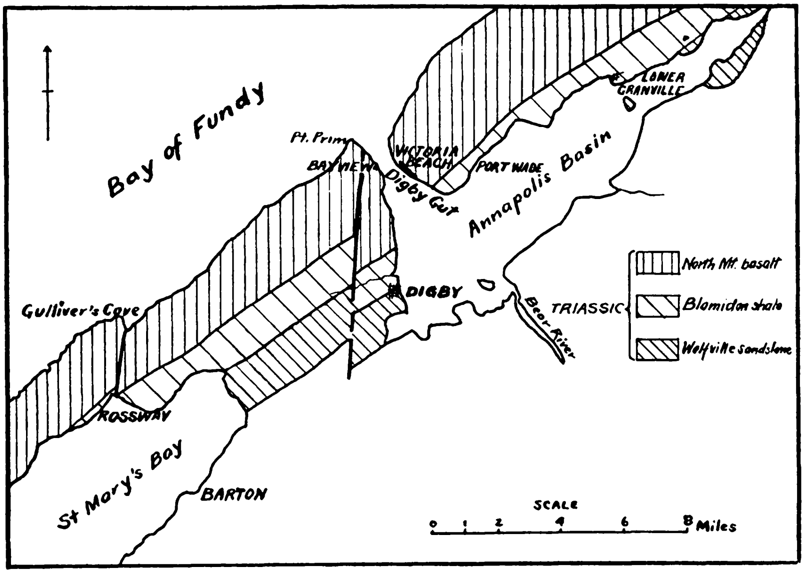

FIG. 30.—Map of the Digby-Rossway region

The section of North Mountain basalt, except the lower flow, which appears at the side of Digby Gut, commences on the Bay of Fundy shore, where 7 flows may be seen (see Fig. 31), each having a thickness ranging from 2 to 45 feet. All the flows dip toward the Bay of Fundy at a low angle, as seen in Fig. 32, but this uniform slope is in places interrupted by minor folds. The presence of a low syncline and the lack of exposures make the exact thickness of the lower flow uncertain, but it is probably about 600 feet.

Faults occur at right angles to the axis of North Mountain, at Digby Gut and at Bay View (Fig. 33). The physiographic evidence of these faults is seen in the offset of the North Mountain basalt, and in the valleys along the fault-lines.

On the shore of Annapolis Basin near Port Wade, and at Digby, there are exposures of slightly cemented sand, containing blocks of basalt, which were considered by Bailey to be of Triassic age, and to underlie the basalt flows of North Mountain.[1]

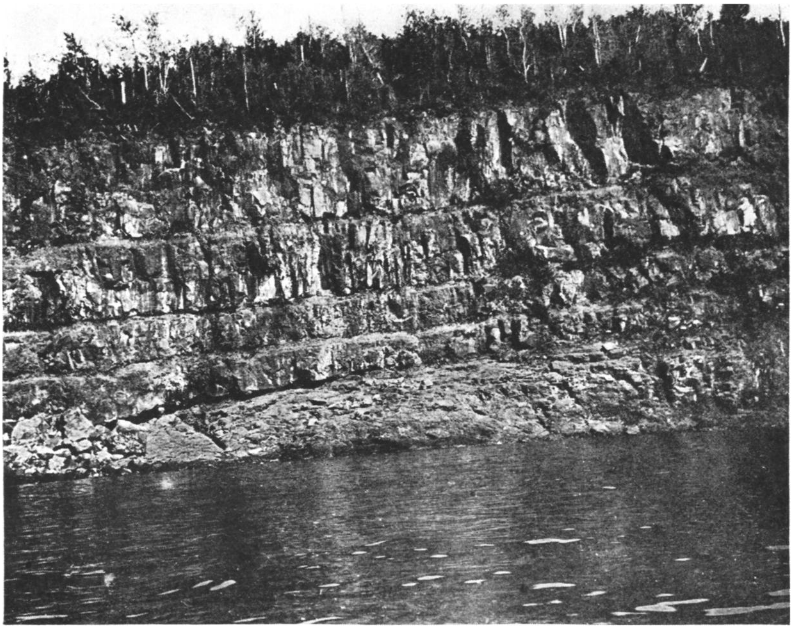

Fig. 31.—Five lava flows of North Mountain at Digby Gut, as seen north of Victoria Beach, on the northeast side of the Gut. The upper flow is the third from the top of the series as exposed.

These beds are of post-Wisconsin age, because of (1) the lack of consolidation, except very locally; (2) the yellow color, like ordinary stream gravels (unlike any Triassic deposit except the

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[1] L. W. Bailey, "Triassic (?) Rocks of Digby Basin," *Trans. N.S. Inst. Sci.*, IX (1898), 356–60; also "Geology of Southwestern Nova Scotia," *Geol. Surv. Canada*, IX (1898), 126 M.

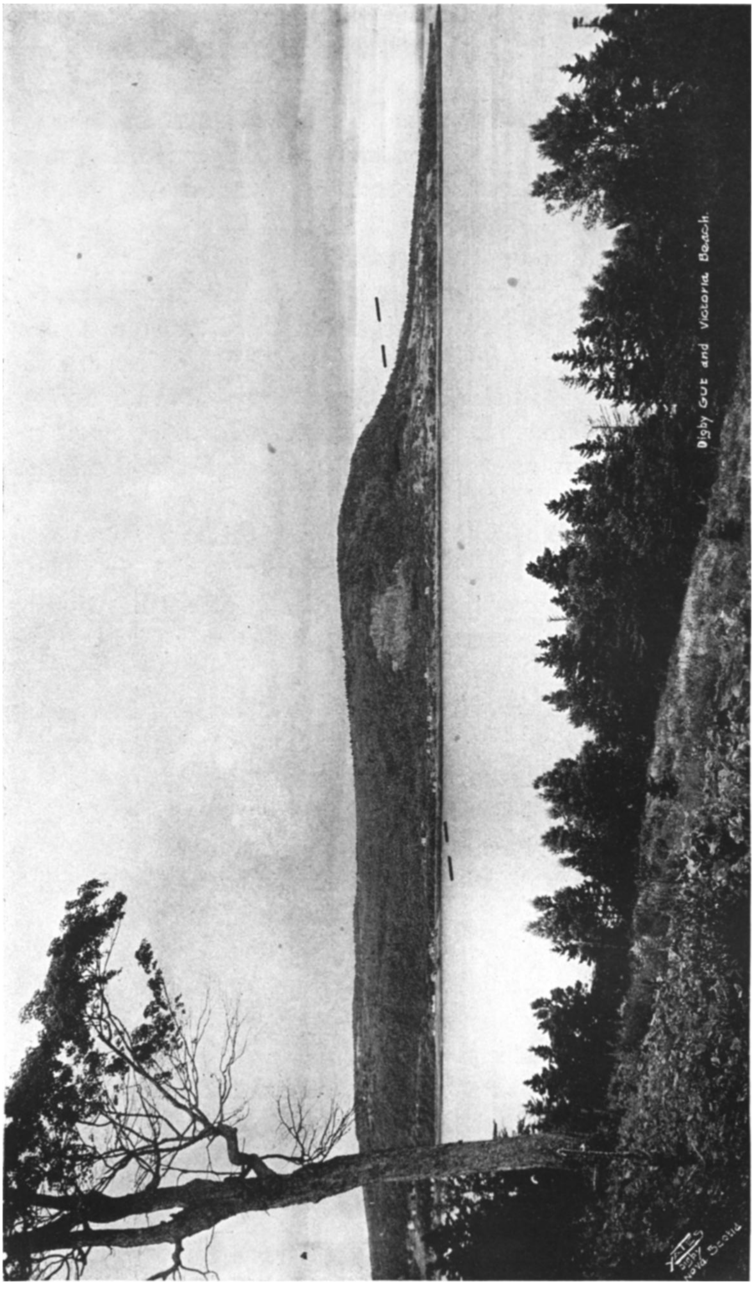

FIG. 32.—The section through North Mountain on the northeast side of Digby Gut. The village of Victoria Beach is seen on the opposite shore. North Mountain consists of basalt flows dipping to the north at approximately the angle seen in the dip-slope at the extreme left. The base of the flows is just beneath the landslide on the mountain near the center of the picture (as shown by dashes). Below and to the right of this landslide is red shale which has been weathered back to produce the escarpment on the south side of North Mountain.

Quaco conglomerate); (3) the lithological character and the lack of green laminae; (4) the delta character of the deposit at Digby; (5) the basalt fragments decreasing in number with increasing distance from the talus of North Mountain basalt; (6) the horizontality of the stratification (the red and green Triassic shales near Victoria Beach dip northward at an angle of 3°).

Rossway-Brier Island.—At Rossway on St. Mary's Bay (Fig. 30), there are excellent exposures of red shale, with occasional green beds and red sandstone beds, comprising the Blomidon shale. Rossway and Gulliver's Cove are connected by a valley which marks a north-south fault similar to that at Bay View. The displacement of the fault may be seen at Gulliver's Cove, in columnar basalt. No thin flows are shown here, or along Digby Neck to Brier Island.

The Blomidon shales at Rossway have a thickness of about 500 feet. They dip northward at angles up to 10°. No other shales in the Acadian Triassic are as well consolidated. Ripple marks, current undulations, cross-bedding, and rarely mud cracks are seen in the shales.

On the shore of Digby Neck, west of Rossway, the shales are exposed for a mile, dipping under the basalt. Half a mile west of the first exposure are Pleistocene clays containing black lignite and basalt fragments. This clay may have been deposited in the post-Wisconsin submergence.

Digby Neck, Long and Brier islands show in common a depression in the center of the ridge, parallel to the strike of the lava flows. This depression marks the amygdaloid at the top of the lower flow, as portions of but two flows are shown above the sea. No sedimentary rocks are shown on the St. Mary's Bay side west of the exposure near Rossway.[1]

Cross-faults are shown between Digby Neck and Long Island, and between Long Island and Brier Island. Another fault probably occurs between Brier Island and the submerged ledge on the

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[1] A. Gesner described red sandstone exposed off Brier Island at low tide, but he probably mistook either the red seaweed or a hematite stain over basalt for sandstone (*Remarks on the Geology and Mineralogy of Nova Scotia*, Halifax, 1836).

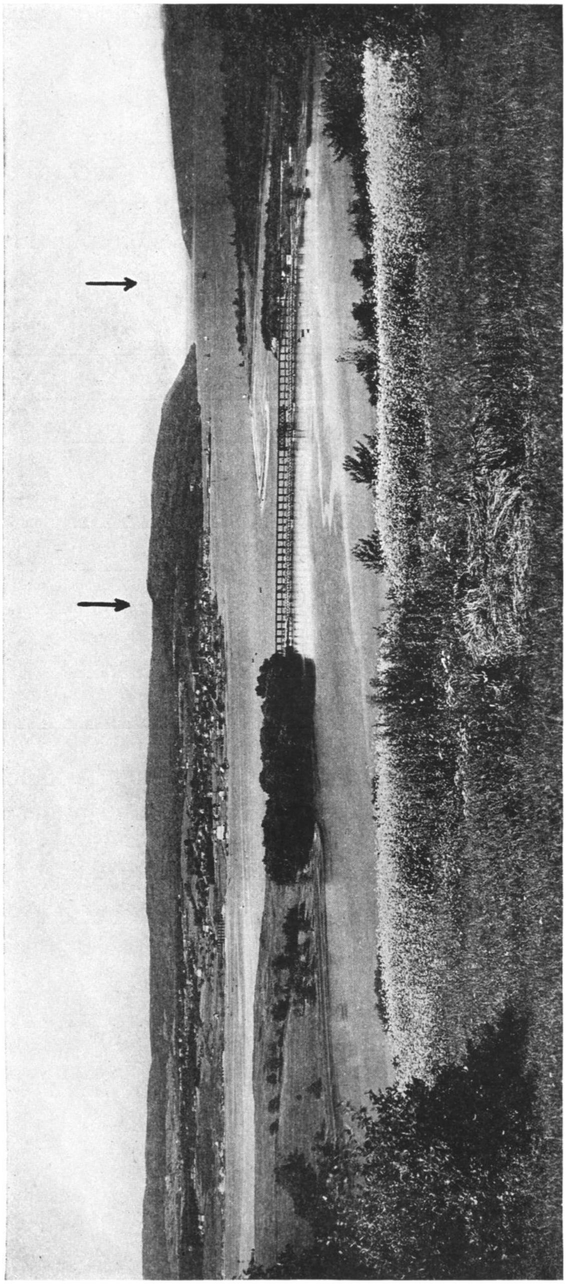

FIG. 33.—Digby Gut and Digby from the foot of South Mountain. The top of North Mountain, in the distance, marks the Summit peneplain. The arrow on the left points to the notch which marks the Bay View fault. The arrow on the right points to Digby Gut, which was probably formed on a similar fault-line. The block between the arrows stands relatively nearer Digby than the remainder of North Mountain on the left, because the downthrow of the cross-faults is on the southwest.

west. Beyond this ledge there is no evidence of the existence of any Triassic rocks.

AGE

The age of the Newark group must be determined by a comparison of its fauna and flora with that of Europe where the Triassic system is well developed. As forms common to both countries are not abundant, there are slight differences of opinion as to the exact correlation. Table I gives a correlation scheme which is modified from one given by Eastman.[1]

Trias	Great Britain	Germany	Eastern U.S.
	Rhaetic	Rhaetic	
Upper	Keuper marl Keuper marl (Upper Keuper sandstone)	Upper Middle } Keuper Lower	Newark group
Middle	Lower Keuper sandstone	Lettenkohle	
		Upper Middle } Muschelkalk Lower	
Lower	Upper variegated sandstone Pebble beds Bunter sandstone	Buntersandstein	

On the evidence of the fish fauna Eastman[2] concludes that the Newark is to be correlated with middle and upper divisions of the Alpine Trias (the Upper Muschelkalk–Middle Keuper of the German section). The plants indicate a similar age, and several forms have been cited as the equivalent of the Lettenkohle forms of Germany.

In the Acadian area the fossils which have been found are: plant remains at Split Rock (Gardner's Creek), Quaco, and Martin Head, New Brunswick; fish remains in the Scots Bay formation at Scots Bay; and impressions of the shells of bivalved crustaceans in drift material from the Blomidon shale, found near Kingsport.

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[1] C. R. Eastman, "Triassic Fishes of Connecticut," *Conn. Geol. and Nat. Hist. Surv., Bull. 18*, 1911, p. 26.

[2] *Ibid.*, p. 29.

The plant remains were described by Dawson[1] from poorly preserved material as *Dadoxylon Edvardianum*. They consist of silicified plant-stems and of lignite, showing pith-casts. At Gardner's Creek and at Vaughan Creek (Quaco), the material is largely silicified, and appears to have been transported some distance. At Martin Head, lignite is exposed in several horizons and is quite abundant. Silicification has not replaced the plant tissues to such an extent as in the other localities.

The Martin Head locality is the only one where material is available for study. Miss Holden has recently examined the lignite, and found two species of plants.[2] The form which was assigned by Dawson to the genus *Dadoxylon* has been found to be identical with *Voltzia coburgensis* Schaur., from the Lettenkohle and Lower Keuper of Germany. The other form is *Equisetum rogersii*, Schimper, which has been described by Fontaine from the Virginia Triassic.[3]

The correlation of these forms is also considered by Miss Holden. The *Voltzia* is apparently the same as the form described by Newberry as *Palissya* from the New Jersey area,[4] and as the form *Cheirolepis* from New Jersey and Virginia. The *Equisetum rogersii* is probably identical with *E. columnaris*, described by Bronn, from the Lettenkohle.

Fragmentary fish remains have been found by Haycock[5] at Scots Bay in the calcareous sandstones overlying the basalt. Recently further collections have been made by Professor Haycock and the material has been identified by Mr. L. M. Lambe, of the Geological Survey of Canada, as probably *Semionotus fultus* (Agassiz), a form common to the other Newark areas.

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[1] J. W. Dawson, *Acadian Geology*, 3d ed., 1878, p. 108; also, *Notes and Addenda*, p. 99.

[2] Ruth Holden, "Fossil Plants from Eastern Canada," *Annals of Botany*, XXVII (1913), 248–54.

[3] W. M. Fontaine, *U.S. Geol. Surv., Mono. 6*, 1883.

[4] J. S. Newberry, *U.S. Geol. Surv., Mono. 14*, 1888.

[5] E. Haycock, "Records of Post-Triassic Changes in Kings County, Nova Scotia," *Trans. N.S. Inst. Sci.*, X (1900), 287–302.

In fragments of shale found in the drift near Kentville, by Haycock, are impressions of *Estheria* of two slightly different types, both of which must be provisionally called *E. ovata*. The shale fragments were evidently derived from the Blomidon shale, and they are very similar to some of the hard barren shale exposed at Rossway.

The paleontological and paleobotanical evidence proves that the Acadian area is a part of the Newark system, and further shows a pronounced similarity between the Newark and the Lettenkohle of Germany.

[*To be continued*]